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British Museum (Natural History).

Instructions for Collectors:

No. 5.—DIPTERA (TWO-WINGED FLIES).

THIRD EDITION

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How to Collect Diptera (Two-Winged Flies),

With Notes on the Habits of the Perfect Insects and Larvæ.

List of Articles Required.

An entomologist's collecting-net.—This can be obtained from any dealer in natural-history apparatus. Any net used for collecting butterflies will do for Diptera ; but, on the whole, perhaps an ordinary umbrella-net will be found the most serviceable. One or two spare net-bags should be kept in readiness in case the one in use gets torn.

Two dozen glass-bottomed *cardboard pill-boxes* (assorted sizes, up to $2\frac{1}{4}$ inches in diameter, packed in nests one inside another).*

One or two *cyanide killing-bottles*, not too large to be carried in the pocket when required; or a larger-sized cyanide killing-jar, or

* These boxes can be obtained from Messrs. Watkins & Doncaster, 36, Strand, London, W.C.; but care should be taken to see that the *bottoms*—and not the tops, as is often the case—are made of glass. Since the boxes are constructed of cardboard, they are liable in tropical countries to go to pieces in the rains ; and to prevent this they should be covered with jaconet in the following manner, the important point to remember being that the jaconet must be cut in strips *on the cross* :—Obtain, say, a square yard of the material, and fold it into a triangle by bringing two opposite corners together. Consider how wide the strips must be, according to the varying depths of the boxes to be covered, and rule them off in pencil by drawing lines *parallel to the base* of the triangle. Cut up the strips, or if possible get them cut by a book-binder's machine. Paint the box over with liquid glue, and wrap the jaconet round it: it is particularly important that the edges of the glass and lid should be well protected, and it will be found that by gently pulling the jaconet it will wrap itself round these without difficulty. When quite dry, say the following day, the box should be given a coat of Aspinall's enamel, or of paint; a second (and if necessary a third) coat of paint being added after the first is dry. Any paint or glue on the glass can be removed with a penknife ; if the jaconet protrudes too far over the glass, cut it round with a penknife and remove it. (Glass-bottomed boxes already protected in this manner can be obtained from Miss E. M. Bowdler Sharpe, Entomological Agency, 34, Barrow-gate Road, Chiswick, W.)

A simpler method of protecting the boxes is to coat them (especially the joints) with shellac dissolved in absolute alcohol.

Glass-bottomed boxes of this kind constructed of tin are sometimes sold ; but these are not to be recommended, since when in use in warm climates they are apt to become very hot, with the result that flies contained in them are killed and become dry prematurely.

materials for making same, as follows : ¼ lb. of cyanide of potassium,* 1 lb. of plaster of Paris, a glass jar with wide mouth and closely fitting lid.†

Entomological Forceps.

Entomological forceps (two pairs), with curved ends for holding pins (from G. Buck, 242, Tottenham Court Road, London, W.).

Fine-pointed forceps (one or two pairs): these are useful for arranging the legs and wings of specimens when pinned; they can be obtained with the above.

Needles (two or three) *mounted in handles*,—also for arranging legs and wings.

* If it is intended to take cyanide to a damp tropical climate, it should be conveyed in the form of *lumps*, in a bottle with a tightly fitting glass stopper. Cyanide of potassium is also sold in rods, and, in this form, might be conveniently carried in short lengths in hermetically sealed tubes of thin glass, of diameter and length just sufficient to take the section of cyanide rod.

† Cyanide killing-bottles can be procured ready for use from Hinton & Co., Bedford Street, London, W.C., or any other chemist will prepare one to order; but when Diptera are collected in the manner advised below, it is preferable to use a large-sized killing-jar, which should be made as follows:—Take any fairly large glass jar (such as a pickle-bottle) with a wide mouth and closely fitting lid (a lever-lid such as those often fitted to pickle-bottles would answer admirably), and cover the bottom with a layer of dry plaster of Paris to the depth of ½ inch; pour in above this a layer equal in depth consisting of *powdered* cyanide of potassium, mixed with rather more than its bulk of dry plaster of Paris; cover this mixture with a layer of dry plaster of Paris to the depth of ¼ inch or so; and pour in above the whole a layer, ½ inch in depth, consisting of plaster of Paris mixed with water to the consistency of cream. As soon as the top layer of plaster is dry the jar is ready for use: the plaster, however, should be covered with several thicknesses of blotting-paper, to avoid risk of injury to specimens in case the surface should at any time become wet. To obviate the danger of cracking the jar owing to the heat evolved when plaster of Paris is mixed with water, it may be advisable to stand the jar in warm water before adding the final layer. The exact amount of cyanide of potassium to be used is of no great consequence; but in the case of a properly prepared jar the odour should be readily perceptible on removing the lid: if it is not, the reason may be that the mixture is too dry, when a little water poured on to the top layer will probably set matters right. After some months' use the cyanide loses its efficacy (to obviate this so far as possible the jar should never be allowed to remain open), and the mixture must then be renewed.

A rough-and-ready method of making a killing-jar or bottle is to cover the bottom with a layer of powdered cyanide, and to place above this a number of layers of blotting-paper. The layers of blotting-paper immediately in contact with the cyanide must be slightly damped; but only sufficient water should be used to cause the cyanide to give off its odour. The top layer of blotting-paper must on no account be wet, and the less water used the better.

Entomological pins (D. F. Tayler & Co., New Hall Works, Birmingham), Nos. 5 (1*s.* 6*d.* per ounce), 7 (2*s.* 6*d.* per ounce), and 20 (7*s.* 6*d.* per ounce). The No. 20 pin should be used for all but the very largest Diptera, such as Horse-flies (Tabanidæ) and Robber-flies (Asilidæ); as it is exceedingly fine, an ounce will go a very long way.

Common pins.—A thousand or two, in paper packets.

Gun-wad punches, Nos. 4, 12, and 20 bores (from any gun-maker), for punching discs of card.

Cards (3-sheet Bristol board), from which to punch discs; a supply of the latter should be prepared ready for use.

A platyscopic lens (Messrs. Baker, 244, High Holborn, London, W.C.; or John Browning, 63, Strand, London, W.C.: price about 15*s.*). The magnifying-power should not be too high—from 10 to 15 diameters is about the best.

Cork-carpet or pith.—Two or three sheets about 6 inches square, on which to perform the operations of pinning, etc. (Cork-carpet can be obtained at Harrod's Stores, Brompton Road, London, S.W.)

Two or three cork-lined entomological store-boxes.—These can be obtained from Messrs. Watkins & Doncaster, or any other dealer in natural-history apparatus. For a collecting trip or expedition of some duration the boxes should not be smaller than about 18 inches by 12, and they must be sufficiently deep to prevent the heads of the pins from coming into contact when both sides of the box are filled. Should the collector run out of store-boxes, *cigar-boxes*, in the bottom of which is fixed a layer of cork-carpet or pith, make efficient substitutes; but if pith is used, it should not be less than $\frac{1}{2}$ inch thick.

Alcohol, 90 per cent. (ordinary rectified spirit).

Perchloride of mercury, aqueous solution, 1 in 500.

For protecting collections in the Tropics: *creosote*, *naphthaline*, *chloroform*.

How to distinguish Diptera from other Insects.

Apart from a few aberrant forms of small size, which are wingless, Diptera may be distinguished from all other insects* by the fact that they possess *only one pair of wings*. Thus, besides ordinary flies, such as Blue-bottles and House-flies (*Muscidæ*), the order also includes Midges (*Chironomidæ*), Gnats or Mosquitoes (*Culicidæ*), Daddy-long-legs (*Tipulidæ*), Horse-flies (*Tabanidæ*), etc.

How to distinguish the Sexes.

In the majority of Diptera the sexes may easily be distinguished by the fact that the eyes meet together (or nearly so) on the fore-

* With the exception of the winged males of Coccidæ (Scale-insects), from which they may be distinguished by the presence of a pair of little knobbed organs (the halteres or balancers) behind the wings, and the absence of filaments protruding from the hinder end of the body.

head in the male, but are more or less widely separated in the female. With the exception, however, of a few small families, this does not apply to the Orthorrhapha Nematocera [Gall-midges (*Cecidomyidæ*), Fungus-midges (*Mycetophilidæ*), *Chironomidæ*, *Culicidæ*, and *Tipulidæ*], the Diptera that are gnatlike in shape and possess long antennæ; neither is the character found in the Robber-flies (*Asilidæ*), the *Dolichopodidæ* (shining green, narrow-bodied, long-legged flies, usually found in the vicinity of water), nor in the vast army of Diptera (chiefly of small or moderate size) included in the families which it is customary to designate comprehensively by the term *Acalypterate Muscidæ*. In these cases, where no sexual distinction is furnished by the eyes, it is usually possible to determine the sex by an examination of the terminal segments of the abdomen: in the male the abdomen ends more bluntly, while the clasping organs are often very conspicuous; in the female the tip of the abdomen is generally more or less tapering, showing indications of the presence of an ovipositor, which is often extruded. In the Gnats or Mosquitoes (*Culicidæ* *) the sexes can readily be distinguished by the antennæ, which in the male are plumose, forming tufts in front of the head, while in the female they are nearly bare; in the Midges also (*Chironomidæ*) the antennæ in the male form plumes, while in the female they are quite short and inconspicuous. In certain families (*Dolichopodidæ*, *Empidæ*) secondary sexual characters are often furnished by the legs; where this is the case, it usually takes the shape of abnormal expansions of some of the tarsal joints in the male.

As a rule among Diptera *the sexes of the same species are alike in coloration*, or at any rate resemble one another pretty closely, striking sexual differences in this respect (such as are commonly seen among butterflies) being exceedingly rare.

When and Where to look for Diptera.

With the exception of Gnats or Mosquitoes, Midges, and similar forms, Diptera are most active when the sun is shining. In hot countries the hours from 8 o'clock till noon and from about 4.30 till sunset are usually the best for collecting. In England the best months for collecting are May, June, and July; but many species are to be found until late in September, while others occur in April or even in March: much of course depends upon the year, the season being sometimes a full month earlier or later than usual.

The following hints on collecting have been kindly furnished by Lieut.-Colonel J. W. Yerbury, who has had great experience in collecting Diptera both in this country and abroad:—

* For collecting this family, see special instructions ("How to Collect Mosquitoes").

"Diptera are to be found everywhere. Still, the following points should always be considered:—

"**Locality.**—In temperate climates virgin soil is best, with a south or west aspect for choice.

"In the Tropics shelter from the prevailing wind is the most important point.

"Shelter, however, is an important factor everywhere, and the line taken should be selected with due regard for the direction of the wind.

"**Habits.**—The habits of the various families differ greatly, and, as a natural consequence, their favourite localities vary also. Before discussing these in detail, it may be advisable to enumerate some of the general attractions for the order.

"*Flowers.*—Some flowers are particularly attractive to Diptera, and these are as a rule white or yellow in colour.

"In England the flowers of the following may be enumerated as specially attractive: common and Portugal laurel, holly, black-thorn, hawthorn, bramble, plane, barberry, and at times rhododendron and dog-rose; but the attraction of the two latter does not as a rule last long. Probably all these are equally attractive in Europe, and to them may be added dane-wort (*Sambucus ebulus*).

"In the tropics Diptera should be looked for on the flowers of several palms and various species of Bher-trees (*Zizyphus*), etc.

"*Sugar*, as applied by Lepidopterists, has not as a rule much attraction. Still, occasionally it is attractive to Calypterate *Muscidæ*, and in a lesser degree to *Stratiomyidæ*; while at night many Daddy-long-legs (particularly *Limnobia*) come to sugar.

"*Ordure.*—Many Diptera are attracted by this — not only *Scatophaginæ* and *Muscidæ*, but Diptera of families which one would not expect to see, the moisture being the probable attraction.

"*Living Animals.*—Many species of *Tabanidæ* and other families are to be seen round living animals, but as a rule are not to be caught, the exception being the *Hippoboscidæ*, which can often be taken with ease. It is seldom possible to catch flies round animals, domestic or otherwise, with a butterfly-net; but occasionally they can be caught with the hand, or boxed.

"*Dead Animals.*—Carrion is sometimes very attractive, and many rare species not met with elsewhere are to be taken on it. Here again the moisture is probably the attraction. A place where blood has run over the ground is generally attractive, though, strange to say, the wet mud and sand in river-beds, so attractive to butterflies in the Tropics, has no attraction for Diptera.

"*Other Attractions—Sweeping—Beating.*—Other attractions, such as leaves, tree trunks, bare sandy places, etc., had perhaps better be considered under the head of attractions to families. One method

of capture should not be omitted, however, and this is *sweeping*. Many species of Acalypterate *Muscidæ*, and also many small *Syrphidæ*, which otherwise would probably be entirely overlooked, may be taken in this manner. The best places to sweep over are damp marshy spots, overgrown with rushes, flags, cotton-grass, etc. *Beating* seldom repays, though *Cyrtidæ* may now and again be obtainable by this means alone.

"**Habits of Various Families.**—*Syrphidæ* (Hover-flies, Drone-flies, etc.).—For this family sunshine is absolutely essential, and the majority will be found at flower heads, in company with many species of *Muscidæ*. Some few, however (e.g. *Xylota, Calliprobola, Brachypalpus*), prefer leaves and tree trunks; while species belonging to certain genera (*Pelecocera, Melanostoma*, etc.) will probably be taken chiefly by sweeping. Many species of *Syrphus, Eristalis*, etc., may be taken hovering in the air.

LEUCOZONA LUCORUM.

"*Bombylidæ* (Humble-Bee-flies, etc.).—The species of the Anthracinæ branch of this family are generally to be found hovering in the hottest sunshine over bare spots on heaths, seashores, etc. The Bombylinæ, on the other hand, affect flowers—*e.g.* primroses, *Potentilla*, etc. At Aden *Bombylius analis* was found hovering over the flowers of the garden turnip run wild, and probably other Cruciferæ will be found attractive.

BOMBYLIUS DISCOLOR.

"*Asilidæ* (Robber-flies) affect many and varied situations. Roads, bare sandy places, etc., are attractive to some species; others sit on tree trunks, stones, and telegraph posts and wires. Others, again, prefer dry sticks and branches near the ground; while the species of *Damalis* and some few other genera love to sit on bare twigs at about the height of one's eye.

ASILUS CRABRONIFORMIS.

"*Tabanidæ* (Horse-flies) are often to be seen flying round living animals; but few are to be caught in this situation, most of the species of this family being taken flying round oneself or one's companions. A few may be caught sitting on tree trunks, leaves, walls, etc., and a few males taken hovering like *Syrphidæ* in the air.

TABANUS BOVINUS.

MESEMBRINA MERIDIANA.

"*Muscidæ Calypteratæ* may be met with in most situations. The species of many genera (*Idia* in particular) love flowers; others again (*Lucilia*, *Calliphora*, *Polietes*, etc.) are to be found round ordure and carrion. *Mesembrina* and *Rutilia*, in company with many species of Anthomyinæ and *Tachinidæ*, love to sit on tree trunks, and prefer the sunny side.

GASTROPHILUS EQUI.

"*Œstridæ* (Bot- and Gad-, or Warble-flies) are said to hover over mountain-tops. *Hypoderma*, however, is generally to be taken sitting on bare sunny places, in roads, heaths, etc. *Gastrophilus* is often to be seen round horses, and may sometimes be taken with a net; but it may be noted that it is labour wasted to attempt to catch specimens of this genus with a *white* net. *Cephenomyia* sits on stones in spots frequented by deer, and is said to settle not infrequently on human beings who enter its haunts.

TRYPETA CORNUTA.

"*Muscidæ Acalypteratæ* are to be taken as a rule by sweeping, though a few *Ortalidæ*, *Micropezidæ*, *Trypetidæ*, etc., may be captured on leaves and flowers, as well as on carrion and ordure.

"*Other Families.*—As regards other families, many of them will be met with while seeking for those already mentioned; and though the habits, etc., of the remainder are as varied as in the case of the latter, still the specimens encountered fortuitously will probably mount up to a considerable number."

Method of Collecting.

If possible, Diptera should always be brought home alive in the glass-bottomed pill-boxes (to which they are to be transferred on being captured in the net), and should then be killed in the cyanide-bottle or jar immediately before being pinned. As soon as a fly is taken in the net by a dexterous sweep, a sharp turn of the wrist must be given (following a smart downward or lateral stroke in order to bring the fly to the end of the net), in such a way that the end of the net containing the insect falls over the rim and so makes a closed bag from which it cannot escape. The end of the net can then be gathered up in the hand, and the fly forced into a still smaller space, in which it will not be difficult to get it into a pill-box, and then to slip on the lid. If the specimens are small, it is possible with care to get several into one pill-box. Flies may also be transferred direct from the net to the killing-bottle, and so brought home dead; but this method is not to be recommended, since prolonged

exposure to the effects of cyanide of potassium is apt to injure the specimens, the ultimate condition of which, when thus treated, is rarely so satisfactory as if they had been brought home alive in pill-boxes. If, however, it is necessary for any reason to dispense with pill-boxes, and to use the killing-bottle in the open, a little crumpled tissue-paper should be placed inside it; this affords a lodgment for the specimens, and so lessens the risk of their being injured by rolling about. It may be noted that Anthracinæ when placed in pill-boxes are very apt to injure their wings by buzzing about, and large *Tabanidæ*, *Œstridæ*, and certain other Diptera are liable to suffer in the same way. On the other hand, the hairy and scaly body-covering of Anthracinæ is very easily rubbed off, so that if carried in the killing-bottle they must be treated with especial care. It is always advisable when out collecting to carry a killing-bottle for use in case of need, in the event of the supply of pill-boxes running short. Diptera on windows may be captured in pill-boxes; if the edge of the box is slightly raised from the glass on one side, and a little tobacco smoke blown into it so as temporarily to stupefy the fly, it will be found easy to slip on the lid without allowing the insect to escape.

Spirit not to be Used, except in case of Specimens intended for Dissection.

Unless intended for dissection, Diptera must *on no account* be placed in spirit. Since all descriptions of Diptera have been based upon *dried* specimens, flies in spirit have to be taken out, dried, and pinned before they can be examined and compared with descriptions. In drying, however, they invariably shrivel, while immersion in spirit often causes colour-markings to disappear, and inevitably results in hairs, scales, etc., being washed off or matted. *Specimens intended for dissection* (as when it is desired to examine some specially remarkable structure, such as the proboscis or genitalia) should, however, be treated in the following manner*:—The flies must be fixed by heat, since their chitinous envelope is penetrated so slowly by alcohol that, if this be not done, they decompose before the preservative can reach them. It is sufficient to bring them to boiling temperature in a test-tube of water, but for delicate histological work it is better to boil in a mixture of equal parts of 90 per cent. alcohol (ordinary rectified spirit) and aqueous solution of perchloride of mercury, 1 in 500. Even protozoal parasites are well preserved by this method. When fixed, preserve in 90 per cent. alcohol. *Methylated spirit* should *not* be used, since its acidity

* The details of this method have been kindly supplied by Lieut.-Colonel G. M. Giles, I.M.S. (Retired), who has found that the process answers well in practice.

and other impurities may lead to embarrassment in the use of aniline stains. The specimens should be preserved in small glass tubes, with a plug of soft paper placed inside on the top of the specimens to prevent them from being injured by washing about. A slip of paper, on which all necessary data should be written clearly *in pencil*, should be placed *inside* each tube, and pinned specimens of the same species should be labelled with a reference to those in spirit, so that the latter may be identified. If it be intended to send Diptera thus preserved to England from the Tropics, the tubes containing the specimens should preferably be placed for transmission inside a larger bottle of spirit; if this be done, it is only necessary to secure the mouth of each tube by tying muslin over it. Cotton-wool, or, better still, horse-hair or shavings, should be inserted as packing between and especially on the top of the tubes.

Killing.

Diptera brought back alive after a day's collecting should be killed by being placed for a few minutes in the closed cyanide-bottle or jar. If the cyanide-jar is sufficiently large, the pill-boxes themselves may be placed therein, first opening them a fraction of an inch on one side to allow the cyanide to take effect. In the case of large sluggish Diptera, such as *Stratiomys*, the pill-box may be opened without fear of the insect effecting its escape; after which a smart tap on the bottom of the box will cause the fly to drop into the jar. Diptera should never be allowed to remain exposed to the effects of the cyanide longer than is necessary to ensure their being quite dead. If the poison is of reasonable strength, four or five minutes should be sufficient to kill even the largest and strongest flies; on the other hand, it is necessary to make sure that the insects are really dead, since, if the exposure to cyanide has been too short, flies will often appear to be dead when in reality they are only stupefied. As soon as the insects are really dead, they should be removed from the killing-jar; those in pill-boxes may be allowed to remain therein until one is ready to pin them, while the loose specimens should be turned out on to a sheet of cork-carpet or pith.

Methods of preserving Diptera other than by pinning.

Diptera should always be pinned, and this should be done as soon as they are dead. If preserved in any other way, they will never make such satisfactory specimens.

When, however, it is impossible to pin them, Diptera may be preserved in fine sawdust, on which a few drops of medical (beechwood) creosote should be sprinkled to prevent mould. Each specimen, before being placed in the sawdust, should be loosely screwed up in fine

tissue-paper (cigarette-paper would do), on which the necessary data (see below under "Pinning") should be written in pencil. To contain the specimens a small tin box (such as those in which tobacco is sold) should be used; and to prevent injury from shaking, the box should be packed *quite full* of sawdust and specimens.

Diptera may also be put away for transport in three-cornered envelopes of soft paper (newspaper), after the manner in which butterflies are packed by collectors; but this method, though it answers fairly well for *Tipulidæ*, does not suit thick-bodied flies, such as *Tabanidæ*, as these are often crushed by it, and if once flattened cannot be restored to their natural shape. Envelopes containing Diptera or other insects may be conveniently packed in tin tobacco- or biscuit-boxes for transmission by parcel-post from abroad. A few drops of dilute creosote should be sprinkled over each layer of envelopes, and the box should be packed quite full.

It is never advisable to put Diptera for transmission from abroad into small boxes containing wool, as when flies are once in contact with wool, and have become dry, it is very difficult to remove them without pulling off legs, bristles, etc.

Pinning.

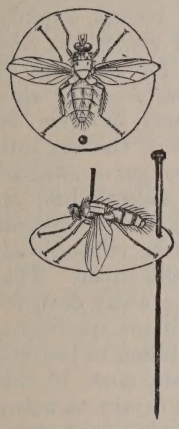
Take a card disc, and write on it all the data connected with the specimen to be pinned, as follows: (1) name of *locality*,* including altitude if necessary; (2) *date*—day, month, year—thus, 30. 6. 08; (3) *collector's name*; (4) any *brief remarks of interest* (which may if necessary be written on the other side)—*e.g.* "Very common"; "Only specimen seen"; "On dead antelope"; "At —— blossom"; "Running on banana leaves." Longer notes on habits, etc., should be entered in a note-book, with a number corresponding to one written on the disc. Specimens taken *in coitû*, for which a good look-out should always be kept when collecting, should have the fact noted on the disc of each, thus: "A—*in coitû* with B"; "B—*in coitû* with A."

Place the disc on which the above particulars have been written on a sheet of cork-carpet or pith, and, picking up with the forceps an entomological pin (a No. 20 if the specimen is not larger than a Blue-bottle, otherwise a No. 7 or No. 5), thrust it through the centre of the thorax of the specimen, until about $\frac{1}{3}$ inch protrudes beneath. If the fly has rows of bristles on the thorax, care should be taken to insert the pin *between* them, and not to damage them in any way. Next grasp the pin with the forceps near the tip, and thrust it through the disc, drawing it well down. Lastly, thrust

* Should this be not likely to be found in an ordinary atlas, the name of the nearest well-known town, or river, bay, mountain, etc., or the approximate geographical position should be added.

an ordinary pin through the disc near the margin for the purpose of carrying both disc and specimen, and draw the disc a good half-way up the carrying-pin.

The last thing to be done is to arrange the legs and wings as far as possible. The wings must be made to project at an angle from the body, and not allowed to remain closed over it; if they can be got to remain at right angles to the body, so much the better. In the case of any specimen that is not too small and fragile, the wings can be best arranged by means of the fine-pointed forceps, by making a gentle simultaneous pressure with the tips of the forceps at the base of each wing, repeating it until the wings assume the desired position. The legs also must be disposed symmetrically (and as far as possible in a natural position) on the card disc, so that all parts of them can be readily seen, and must not be allowed to remain crumpled up beneath the body, since important characters are often found upon them. In the case of a specimen with strong claws (such as one of the Robber-flies) it will generally be found possible to cause the legs to remain in the desired position by hooking the claws on the edge of the disc, gently drawing the legs out one after another by aid of a needle or one leg of the fine-pointed forceps. The manipulations in connection with the legs and wings must be performed as gently as possible, and care must be taken that bristles, hairs, or scales are not rubbed off in the process. As soon as these operations are completed, the specimen should be transferred to a store-box, or to one lined with cork-carpet or pith, as described above. Since, however, the tissues contract in drying, the legs and wings are very apt to get pulled out of place, and, to correct these changes, the specimens should be examined once or twice during the next day or two after being pinned.



USE OF DISCS.

Very minute or fragile specimens are best *pinned from the side*, and the legs should then be straightened out by means of a No. 20 pin held in the entomological forceps.

Diptera collected in the Tropics:

Attacks by Ants—Mould—Transmission to England.

In the tropics boxes of pinned insects are very liable to the attacks of minute *ants*, which, if they once gain access to a box unobserved, will soon play havoc with its contents. In Brazil it has been found

that ants can be prevented from entering insect-boxes by smearing the outside round the line where the box opens, or any other possible place of entrance, with *andiroba* oil, repeating the process as often as necessary; similar methods might be employed elsewhere in case of need.

Mould, however, is an even greater enemy to collections of Diptera. Pinned specimens of Diptera, like those of other insects, rapidly develop mould during the rainy season in tropical countries; and since mouldy specimens are practically worthless for purposes of scientific determination, *Diptera should always be sent home as soon as possible after being collected.* The risk of mould may, however, be entirely prevented by thoroughly rubbing the inside of the box into which the specimens are pinned with a piece of sponge, or swab of cotton-wool, soaked in a saturated solution of naphthaline in chloroform, mixed with an equal quantity of ordinary medical (beechwood) creosote. The inside of the box should be rubbed with the mixture until the cork-lining shows through the paper. This method possesses the additional advantage of keeping away destructive insects. The fluid must not be allowed to touch the specimens, or they will be injured. The greatest care must be taken to prevent specimens getting loose and rolling about in transit, since in this way a single loose disc might easily do irreparable injury to many other specimens in the box. To prevent this the pins supporting the discs should be inserted as tightly as possible into the cork-carpet or pith, and they should all be driven in to the same level, after which a sheet of soft paper (newspaper does very well) can be *fixed* into the box, resting on the heads of the supporting pins, in order to minimise the damage should a disc happen to get loose. The box containing the specimens should be well wrapped in cotton-wool or similar material, and firmly *packed in an outer case* for transmission (by parcel-post if possible and if the package is not too large) to England.

Number of Specimens of each Species required.

At least half a dozen specimens of *each sex* of a species should, if possible, always be obtained, and a good look-out should be kept for specimens showing any abnormality in structure, coloration, or size. When the collector remains long enough in one spot, he should always endeavour to obtain specimens of a species on different dates, in such a way as to throw as much light as possible on the duration of its seasonal occurrence. Similarly the attempt should be made to illustrate the geographical range or local distribution of a species by collecting specimens in as many different localities as possible. Specimens of species taken in new localities, though common elsewhere, will always be valuable.

Larvæ and their Habits.

The habits of Dipterous larvæ are as varied as the outward appearance of the larvæ themselves. The latter may be met with almost everywhere, but especially in decaying matter of all kinds, in water both running and stagnant, in the ground, attacking the roots and bulbs of plants, or mining in the stems and leaves. It is worth noting, especially as a means of distinction from Coleopterous larvæ, that *no Dipterous larva is possessed of true* (*thoracic*) *legs*, though in many species (e.g. *Eristalis*, *Helophilus*) prolegs or transverse ridges having a similar function are distinctly visible.

The following notes as to the mode of life of the larvæ of some of the best-known families of Diptera may be useful :—

The tiny pink- or scarlet-coloured grubs of the Gall-midges (*Cecidomyidæ*), as their name implies, form galls on the leaves and stems of plants.

The white grubs of the Fungus-midges (*Mycetophilidæ*) have black heads, and are to be found for the most part in fungi and boleti.

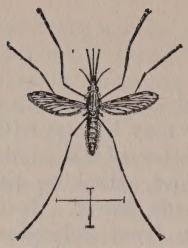
BIBIO MARCI, ♀, WITH HEAD OF ♂.

The larvæ of *Bibionidæ*—a family that includes "St. Mark's fly" (*Bibio marci*, L.) and other species of black flies, which in England are exceedingly common in meadows in spring and early summer, sometimes hovering in the air, dancing in swarms, or feeding on the heads of Compositæ—are similar in appearance to those of Fungus-midges, and may be met with in vegetable mould, or in the droppings of cattle.

The greenish, somewhat leech-like larvæ of the *Simulidæ*—a family that includes a number of blood-sucking species—may be found (with the pupæ) in brooks and streams, adhering to the submerged stems of rushes and other water plants.

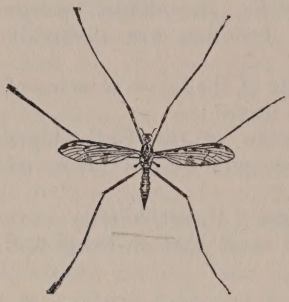
CHIRONOMUS PLUMOSUS.

The mode of life of the larvæ of the true Midges (*Chironomidæ*) is somewhat varied, those of the genus *Chironomus* being aquatic or living in the soil or in droppings (the well-known "blood-worm," so common in rain-water, is the larvæ of *Chironomus plumosus*, L.); the larvæ of the genus *Ceratopogon* (*sensû latiore*), which includes a number of blood-sucking Midges, are found under the bark of trees and in decaying vegetable matter; the larvæ of *Clunio* are marine, living in rock-pools and feeding on green sea-weed (*Cladophora*).



ANOPHELES MACULIPENNIS.

The exceedingly active larvæ and pupæ of Gnats or Mosquitoes (*Culicidæ*) are exclusively aquatic, and are to be found in ponds, tanks, or butts of rain-water, and also in open drains and cess-pools: in the Tropics, in casual accumulation of water in old tins, bottles, calabashes, etc. (*Culicinæ*), or in stagnant or nearly stagnant water in pools, at the side of slowly flowing streams, or in permanent puddles (*Anophelinæ*).



LIMNOBIA NUBECULOSA.

The grub-like larvæ of Daddy-long-legs (*Tipulidæ* and *Limnobidæ*) live for the most part in rotten wood, in water, or in the soil. The grubs known as "Leather-jackets," so destructive to the roots of turf and sometimes to cabbages, are the larvæ of *Tipula paludosa*, Mg., and *T. oleracea*, L.

STRATIOMYS FURCATA.

The larvæ of *Stratiomyidæ* have a hard, armourplate-like integument, and live in water or in humus.

The larvæ of the Horse-flies (*Tabanidæ*) and Robber-flies (*Asilidæ*) are often internal parasites of beetle larvæ; they are whitish, soft-bodied grubs, and in the case of the *Asilidæ* are sometimes considerably elongated. At a later stage the larvæ of *Tabanidæ* have been found in earth or water, those of the *Asilidæ* in earth or in rotten wood.

The larvæ of the Humble-Bee-flies (*Bombylidæ*) are parasitic in the nests of solitary bees, or in the egg-capsules of locusts and grasshoppers.

The habits of the larvæ of the *Syrphidæ* are exceedingly diversified; those of the true Hover-flies (*Syrphus*) may be found on leaves infested with *Aphidæ*, upon which they feed; those of *Volucella* are inquilines in the nests of humble-bees and wasps; the well-known "Rat-tailed Maggots" (such as the larva of the Common Drone-fly, *Eristalis tenax*, L.)—so called from the protrusible, telescopic, terminal segments of the body, which carry the breathing-tubes—live in decaying animal or vegetable matter in a liquid or semi-

liquid state, in foul and stagnant water, drains, and similar places; the larvæ of other genera (e.g. *Brachypalpus*, *Xylota*, *Calliprobola*) live in rotten trees. The larvæ of *Syrphidæ* in general (including all the foregoing) are more or less soft and grublike in appearance; but those belonging to the genus *Microdon*, which live in ants' nests, have a hard, dorsally convex shell, without or with scarcely a trace of segmentation, and are so aberrant in appearance as to have been mistaken for molluscs.

CONOPS FLAVIPES.

The larvæ of *Conopidæ* are parasitic in the bodies of imagines of Hymenoptera (and Orthoptera *).

The larvæ of the Bot-flies and Gad- or Warble-flies (*Œstridæ*) are *mammal parasites*. They are white and grublike in shape, and live in the nostrils, frontal sinuses, pharynx, stomach and intestine, or beneath the skin. The majority are parasitic upon Ungulates; but the larvæ belonging to the American genus *Cutiterebra* are found beneath the skin of Rodents. It may be noted that larvæ belonging to this family rarely survive forcible removal from the host. Pupation invariably takes place upon or in the ground, under stones, etc.; therefore, in order to breed out the perfect insects, an attempt should be made to obtain the larvæ as they leave the host in order to pupate, or the pupæ themselves should be sought for in the situations indicated, in places frequented by the animals. In the case of domestic or other animals, kept in captivity and infested by these parasites, the pupæ or larvæ about to pupate may sometimes be obtained by searching in the stalls or sheds at the proper season. According to Brauer the majority of Œstrid larvæ leave their hosts in the early hours of the morning.

TACHINA FEROX.

The larvæ of the *Muscidæ* (*sensû latiore*) are well known as *maggots*, and are to be found in decaying matter of all kinds, and even in festering sores and wounds on living animals; those of the sub-family *Tachininæ* are parasitic in other insects—the majority in caterpillars.

The habits of the larvæ belonging to the families constituting the *Acalypterate Muscidæ* are too diversified to be dealt with in detail. Some are to be found in ordure; others attack the stems of grasses and cereals; while the larvæ of others again (e.g. *Trypetidæ*) live in fruits, in seed-heads, in galls on the stems, or mine in the leaves of various plants.

* *Physocephala vittata*, F., was bred by Boheman from a grasshopper, *Sphingonotus cyanopterus*, Charp.

How to Preserve Larvæ.

Specimens of Dipterous larvæ will always be valuable, whenever it is possible to breed out some of them so as to determine the fly to which they belong. Unless, however, the perfect insect be known, it is rarely possible to do more than to determine the *family* to which a larva belongs. Larvæ for preservation should be killed by immersion for *a moment or two* in boiling water, and should then be placed in weak spirit (two-thirds spirit and one-third water); after being allowed to remain in this for two or three weeks until thoroughly hardened, they can be transferred to stronger spirit. The larvæ of each species must of course be kept separate, and should be put up in a small, corked glass tube full of spirit, the necessary particulars, with, if possible, a reference to pinned specimens of the perfect insect, being written in pencil on a scrap of paper and placed *inside*.

Notes on Habits, etc.

Very little is yet known as to the habits of Diptera in general, so that notes on the habits, distribution, seasonal occurrence, relative frequency, etc., of particular species will always be of great value and interest.* Particular attention should be paid to the habits of *blood-sucking species* † and others of economic importance. A good look-out should also be kept for cases of *mimicry* between Diptera and Hymenoptera, which will be found to occur chiefly among the *Syrphidæ* (to a lesser degree also among the *Asilidæ*). The *Syrphidæ* as a family may be said to mimic Hymenoptera, but in some genera —e.g. *Volucella*, *Arctophila*, *Calliprobola*—the resemblance is especially pronounced). Instances of mimicry between Diptera and insects belonging to any order other than Hymenoptera are exceedingly rare. *Cases of mimicry between particular species* should be specially noted.

* For special points in connection with Mosquitoes as to which information is desired, see "How to Collect Mosquitoes."

† For notes on *Blood-Sucking Flies*, see Instructions for Collectors : No. 7. "Blood-Sucking Flies, Ticks, Etc." By E. E. Austen. Third Edition. 1907.

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